APPENDIX J

USING THE CHEMICAL LIBRARY TO DETERMINE THE UTILITY OF BORON AS AN INDICATOR OF ILLICIT DISCHARGES

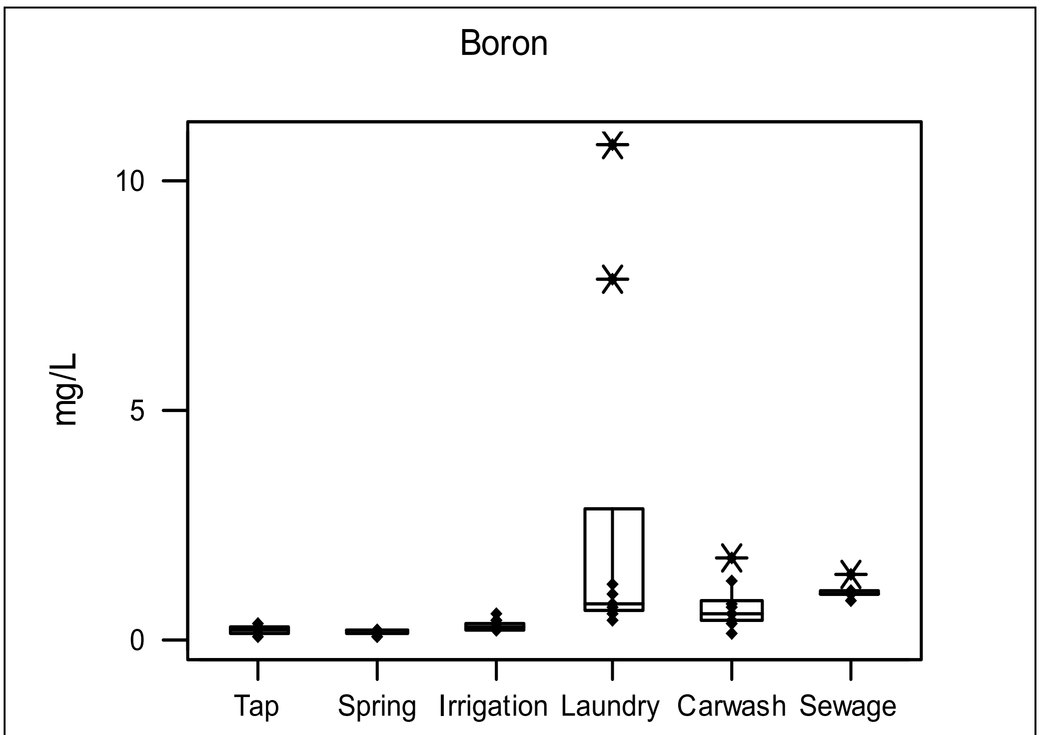
Introduction

In this example, library data from several flow types are analyzed to determine a good cut-off point to use boron as an indicator of illicit discharges. Both the data and the selected concentrations are derived from research in Tuscaloosa, Alabama (Pitt, 2004). Investigators examined the data from their chemical flow library both graphically and then in detail to select a concentration.

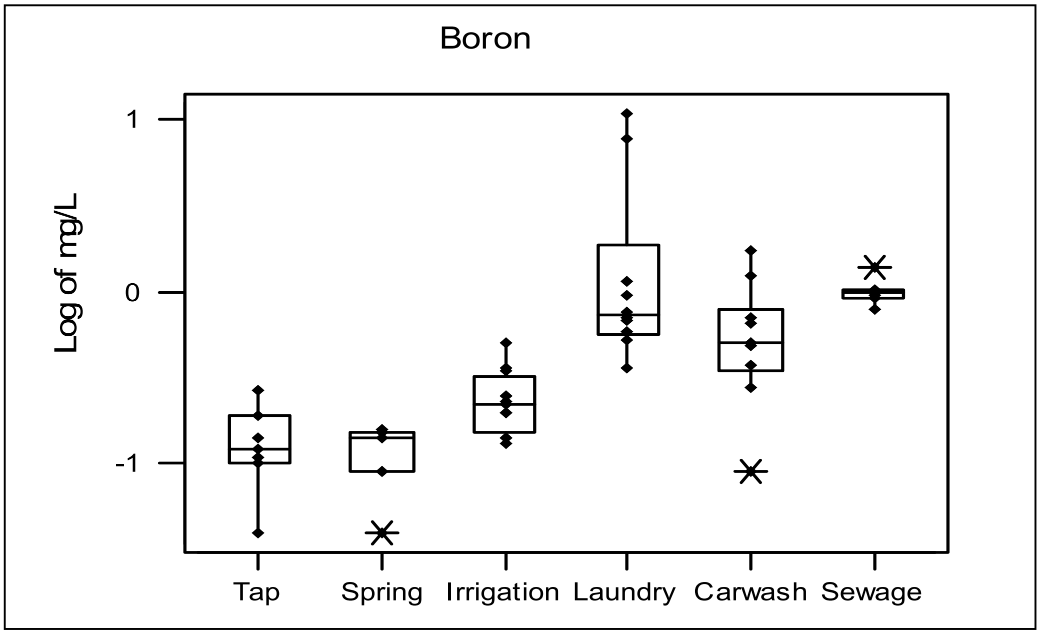
Step 1: Visually Analyze Data Using Box Plots

After collecting data from a select group of flow types, researchers assembled the data into box plots (see Plots 1 and 2). These plots help quickly identify the range of data. The "box" portion of the plot shows the first quartile, median, and third quartile for the data, and the individual data points show the data above and below this range.

A first look at the data shows that sewage, laundry, and wash water sources all have a higher concentration than the non-illicit flows: irrigation, tap water, and spring water. A closer look, using the log plot (i.e., the log of each concentration), shows some overlap between irrigation water and two of the illicit flow types: laundry and car wash. Although this overlap means that there will be some "false negatives" or "false positives" using this parameter, investigators select a concentration that is lower than the lowest concentration in laundry. This value appears to be somewhere between $10^{-0.5}$ (or 0.3 mg/L) and 10^{0} (or 1.0 mg/L).



Plot 1: Boron Concentration
(Source: Pitt, 2004)



Plot 2: Boron Concentration in Log Space
(Source: Pitt, 2004)

Step 2: Evaluate Tabular Data

The first step is a good general indicator of how to use boron as an indicator. The second step refines the initial evaluation to come up with a specific value to use as an indicator, and a numeric estimate of the number of "false positives" (i.e., identifying a non-illicit flow as illicit) and "false negatives" (i.e., identifying an illicit flow as non-illicit) that would result from using the parameter. (See Table below for the data used in this investigation).

Using data from the three sources with overlap, investigators select a concentration of >0.35 mg/L as an indicator of sewage or wash water. (This value captures all laundry flows). Using this value, two of 12 irrigation samples are identified as illicit (a 17% false positive rate) and two of 10 car wash samples are not captured as an illicit discharge (a 20% false negative rate).

Boron Concentration (mg/L) For Six Flow Types (Concentrations >0.35 mg/L indicate illicit discharges)					
Tap Water	**Spring Water**	**Irrigation**	**Laundry**	**Car Wash**	**Sewage**
0.04	0.04	0.13	0.36	0.09	0.78
0.1	0.09	0.14	0.53	0.28	0.93
0.11	0.09	0.14	0.58	0.37	0.97
0.12	0.14	0.2	0.67	0.48	0.98
0.14	0.15	0.2	0.7	0.5	1.01
0.19	0.15	0.22	0.75	0.5	1.05
0.27	0.16	0.23	0.97	0.65	1.38
		0.25	1.16	0.7	
		0.25	7.9	1.23	
		0.35	10.8	1.74	
		0.36			
		0.5			
Yellow shading indicates a false positive. Pink shading indicates a false negative. *Source: Pitt (2004)*					

Step 3: Make a Determination

Based on these data, boron shows high promise as an indicator of illicit discharges. It correctly categorizes all flows from tap water, spring water, laundry and sewage, and has fairly low false positive or negative rates for identifying irrigation and car wash discharges. One potential concern, however, is that dilution occurring at the outfall may mask some illicit discharges. For example, a 50% dilution with spring water (using the median concentration of 0.14 mg/L) would result in a 20% false negative rate for laundry waters and a 60% false negative for car wash waters.

VERDICT: GOOD CANDIDATE FOR FLOW CHART METHOD. NEEDS FIELD TESTING!

References

Pitt, R. 2004. *Methods for Detection of Inappropriate Discharge to Storm Drain Systems.* IDDE Project Support Material.